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The Effect of a Combined Guided and Divergent Discovery Teaching Approach on Handstand Swing Learning on Parallel Bars Among Young Gymnasts Aged 10–12 Years

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Abstract

Purpose study. This study was to examine the impact of a guided discovery as well as a divergent discovery teaching approach on handstand swing skill (on parallel bars) acquisition in 10–12-year-old gymnasts.

Materials and methods. A one-group pre–post research design was used. The study sample included 8 young gymnasts from specific training centers in Baghdad. Subjects participated in a 6-week instructional unit that combined discovery and guided discovery teaching styles at a rate of three units per week for 18 units. Judged by national gymnastics judges, skills were rated in standard judging criteria. Descriptive statistics and paired sample t-tests were calculated to determine differences between pre- and post-test scores at the level of significance ($p \leq 0.05$).

Results. indicated improvement of the handstand swing after instruction. There was a significant difference between post-test scores and pre-test scores, showing that discovery-based learning approaches improved motor learning, coordination and technical execution of the skill.

Conclusions. The combination of guided and divergent discovery teaching styles was effective in facilitating handstand learning on the parallel bars in young gymnasts. The methodology supports learners' engagement, discovery and understanding of movement performance indicating its utility as a learning strategy in the teaching of fundamental skills gymnastic at younger ages.

Keywords: Motor Learning, Guided Discovery, Divergent Discovery, Handstand Skill, Artistic Gymnastics

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Introduction

Motor learning represents a central component of contemporary physical education and sport sciences, particularly within learner-centered movement education frameworks, especially in recent years with a shift from instruction to exploration, problem resolution and engagement in learning skills. Modern theories of learning, such as ecological dynamics and

nonlinear pedagogy stress that skills are learned through a relationship between the learner and task/environment (vs. overlearning via imitation), rendering discovery learning strategies increasingly relevant when it comes to teaching complex motor skills (Komar et al., 2022; Yang et al., 2025). These also focus on maximizing the contribution of adaptability, creativity, and cognitive involvement in learning-concepts that have been argued to be necessary components for transferring effective motor skill development among children or young athletes (Newell, 2021; Richard et al., 2018).

Gymnastics is one of the disciplines that requires high levels of neuromuscular coordination, balance and body displacement (1) and handstand has been described as a very basic skill for developing advanced movements on apparatus such as parallel bars. Early gains in strength may help better with posture control, proprioception and motor coordination - all very important having as base gymnastic-based techniques (Kochanowicz et al, 2015; Morsalfard, 2023). The learning of the handstand skill does not rely only on physical aspects, but it is strongly influenced by teaching methods, practice variability and the practice context, so modern pedagogical framework is needed to maximize its learning outcomes (Crotti et al., 2021; Ghanem, 2025).

Guided discovery and divergent discovery are referred to as a frequent type of teacher implementation in physical education according to pedagogical discourses. In guided discovery, guiding to result in some motor responses is evident through systematic question or task, while a divergent discovery may produce more than one movement response where flexibility and creativity of action are stressed. Among them, learner-centered approaches in computer-mediated control task are found to improve motor learning performance and attentiveness more efficiently than traditional instructional that can be applied by some of these strategies (Hussin et al., 2018; Neamah, 2025). In gymnastics education research, guided discovery has been shown to contribute to learning basic skills such as the handstand, by increasing student engagement and self-regulated performance (Al-Sulieman, 2005; Qawaqzeh, 2023).

There is some empirical evidence that discovery-based instructional strategies can enhance the learning and retention of motor skills. For instance, a study which compared command and guided discovery for teaching the handstand reported that both interventions were beneficial to learning, however, guided discovery proved superior with regard to retention and developmental skill progressions of performance (El Khouri et al., 2020). In a similar vein, didactic teaching- and learning approaches have been reported to benefit in learning basic gymnastics skills like the handstand by models that are constructed on ideas from the constructivist paradigm due to greater motoric engagement and understanding of movement patterns (Rohleder & Vogt, 2018). This evidence provides support to the affordance of discovery-type strategies to enhance effective motor learning in physical education settings.

Despite the Increase of studies about the discovery approach, there are still some gaps in the literature. The majority of previous research has often treated guided discovery as a single instructional method, or at most a single comparison with traditional approaches, and few have looked directly at comparisons of different forms of discovery learning, in particular guided versus divergent discovery styles within the same experimental environment. In addition, limited research is available on the training of handstands on parallel bars in this age group; the between 10–12-year-old period represents an important stage for acquiring basic gymnastic skills. Furthermore, previous studies tended to focus only on the teaching strategies or motor learning variables and there was little integration between pedagogical styles and biomechanical skill acquisition in gymnastic environments (Yang et al., 2025; Newell, 2021).

The present study aims to investigate the effect of a combined guided and divergent discovery teaching approach on learning the handstand swing skill on the parallel bars among players aged 10–12 years. The study seeks to determine the extent to which integrating these

discovery-based instructional styles contributes to improving motor skill acquisition and enhancing technical performance within this developmental stage.

The significance of this study is to provide scientific validity for the utilization of contemporary teaching methods in gymnastics with a physical education curricular. The result is to help bridge the theory-practice gap in teaching young children motor skills at a more optimal level of achievement, for coaches/teachers when choosing teaching methods they will use with young beginning lead-up motor skill learners and improved mastery of more involved complex motor patterns by themselves. It also encourages the development of training principles based on modern motor learning theory to enhance skill acquisition in young players.

Based on the study's objectives and a single experimental group using guided and divergent discovery teaching styles, this research is aimed at comparing the effectiveness of a combination of these two instructional approaches in learning the handstand skill on parallel bars among players aged 10–12 years. This study aims to demonstrate the practical significance of implementing discovery-based assumptions in gymnastics training exercises and staying with evidence that could assist coaches and physical education instructors in choosing suitable learner-driven instruction.

Materials and Methods

Research Design

The research problem was addressed using an experimental research design, specifically one where the instructional conditions are deliberately controlled and measured in terms of their effect on performance outcomes. The study used a one-group pre-test–post-test design because suitable control participants were unavailable, and withholding instruction would be unethical.

This is a commonly used design in applied sport and educational research to evaluate the effectiveness of instructional programs when designing work with specialized or small sample sources. This group was instructed with guided and divergent discovery teaching styles via structured instructional units, while performance scores from pre- and post-tests were utilized for measuring the effect of the training intervention, as shown in Table 1.

Table 1. Research design of the experimental group with pre- and post-tests

Groups	Sample Size	First Step	Second Step	Third Step	Fourth Step
Experimental Group	8	Pre-test	Guided and Divergent Discovery Styles	Post-test	Difference between pre- and post-tests

Study participants

Research community: Players who belong to specialized gymnastics centers in Baghdad were (17) players. The sample of the study consisted (8) players (10–12-year-olds) who trained regularly in these distinctive centers and play at Al-Jaish Sports Club. The selection of the subject was deliberate according to age, level and fulfillment of study criteria.

An exploratory sample of (3) players from outside the main study sample was selected to conduct pilot procedures and ensure the suitability of the instruments and tests.

Instruments and Equipment

Tools and devices

Several tools were needed for the gathering and registration of information, namely, Arabic and foreign references in addition to performance recording forms; parallel bars device,

a whistle (whistle model: HSA 16063), stop watch (model: 3050), stationery items used for documentation and organizing of procedures.

The devices used in the study included a personal computer (HP) for data processing and storage, and a Sony video camera for recording skill performance and facilitating evaluation.

Field Procedures

Skill Assessment Test

The technical execution of the handstand swing on the parallel bars was assessed in the pretest, at intermediate measurements and in the posttest. The performance was judged by three world-class gymnastics judges and one first-ranking certified judge of the Iraqi Central Gymnastics Federation. The international gymnastics judging code was used in the evaluation. The top and bottom scores were eliminated, and the average between the two middle scores was determined by using the following equation:

Player score = (Sum of the two middle scores) / 2

This procedure ensured objectivity and accuracy in assessing skill performance.

Pilot Study

Pilot research has been held on 8th of March 2024 at Al-Tahaddi Specialized Center at 3 p.m. The pilot study aimed to confirm whether the chosen tests, instruments and procedures were appropriate for our research sample, and to detect any potential barriers before carrying out our main experiment.

Pre-Test

The pre-test was carried out on Monday 12/4/2024 at (3:00) p.m. in Al-Tahaddi Specialized Center. Standardized conditions for assessment related to studied variables. All possible effort was made to regulate all testing variables such as (time, place, instruments and techniques of execution) to have similar situations for post-test.

Main Experiment

The investigator developed a sequence of instructional units using guided discovery and divergent discovery teaching methods. The professional program was carried out for six weeks at the rate of three educational units a week, total (18) educational units. The exercises implemented were administered only during the main part of a 65- minute YiChuan training unit, as shown in Table 2.

Table 2. Educational Program Schedule Over Six Weeks

Week	Number of Units	Teaching Style Used	Instructional Focus	Duration of Section
Week 1	3 units	Guided & Divergent Discovery	Introduction to handstand skill, body alignment, basic balance	65 minutes
Week 2			Arm support, balance control, initial performance attempts	
Week 3			Improving coordination and stability during handstand performance	
Week 4			Developing swing technique on parallel bars	
Week 5			Enhancing performance accuracy and motor control	

Week 6	Skill refinement and preparation for post-test performance

The class structure was as follows: the instructional portion lasted 10 minutes where players were told and shown how to perform a handstand, followed by a practical component of 55 minutes in which they attempted to do the handstand on the parallel bars. Designs In practice, participants answered structured questions on guided and divergent discovery while the Coach gave feedback and performed corrections during (on-line) and after performance (off-line), as described in Table 3.

Table 3. Structure of the Main Section of the Instructional Unit

Component	Time	Description	Coach Role	Learner Role
Instructional part	10 minutes	Explanation and demonstration of the handstand skill on the parallel bars	Presenting the skill, clarifying key points, providing demonstrations	Listening, observing, asking questions
Practical part	55 minutes	Practical application and performance of the handstand on the parallel bars	Asking structured questions based on guided and divergent discovery styles, providing feedback, correcting errors during and after performance	Practicing the skill, responding to questions, exploring movement solutions, improving performance

In the guided discovery condition, the coach verbally explained the skill and displayed it with demonstrations and multimedia display, then used a series of questions to guide players toward discovering a correct movement solution. The responses to the prompts were answered in private, and were discussed and analyzed during team discussion.

For the diverging discovery approach an open invitation which consisted of open-ended questions set for each technique that required multiple answers (movement solutions), not just one right answer by players, was previously written by researcher. The goal enacted in this approach was to maximize creativity, exploration, and adaptability during the acquisition of a skill. The learning sequence was supported by explanation, demonstration and guided practice.

Post-Test

The post-test was carried out on Friday, 19 April 2024 after the end of the instructional program at 3:00 p.m., under similar conditions with pretest. The researcher and the assisting team maintained constant: time, place, tools and processing of execution to guarantee reliability and validity of results.

Statistical analysis

Data were analyzed using appropriate statistical procedures consistent with experimental research in physical education. Descriptive statistics (means and standard deviations) were calculated to summarize the data. A paired sample t-test was used to examine the differences between pre- and post-test measurements for the experimental group. The level of statistical significance was set at ($p \leq 0.05$).

Results

Following the application of the guided and divergent discovery instructional program, there was a clear improvement in participants' performance in performing handstand swings. The results showed that the post-test scores were higher than pre-test scores, confirming that the instructional intervention was effective for skill acquisition among young gymnasts aged 10–12 years.

In addition to the overall performance improvement, progress in key technical components was observed. Judges' evaluations of judges showed better body alignment, improved balance control, increased support stability on parallel bars, and more coordinated execution during the swing phase. This was reflected in both quantitative improvement in performance outcomes and qualitative refinement of the technical execution.

The mean difference between pre- and post-test scores (5.10 points) represents a meaningful practical improvement — it indicates that learned skill changes are meaningful, as opposed to just statistical ones. It indicates that the delivery of both guided and divergent discovery teaching styles in an integrated approach had a major positive impact on motor skill development skills for handstand swing motor control and execution efficiency.

Overall terms, the results directly address the research objective and confirm that the combined instructional method resulted in significant improvements in motor coordination, technical stability and overall performance quality of the handstand swing skill in Table 4.

Table 4. Differences Between Pre- and Post-Test Scores for the Handstand Skill

Variable	Test	Mean	SD	Mean Difference	Std. Error	t (calculated)	t (critical)	p-value
Handstand skill	Pre-test	3.10	0.74	5.10	0.29	17.49	2.78	≤ 0.05
	Post-test	8.20	1.03					

Discussion

The results of the current investigation showed that the integration of guided and divergent discovery teaching styles had a positive add-on effect in learning parallel bar handstand skill (increased between pre- and post-measurement). This enhancement can be explained through current motor learning principles, where active participation, exploration and learner-centered teaching are considered as key factors for the mastering of a complex movement skill such as gymnastics.

Exploratory learning methods stimulate learners to develop movement solutions on their own, thus promoting cognitive involvement and favoring the retention of motor skills. Previous studies have demonstrated that guided discovery is effective in developing gymnastic skills, as it enables students to comprehend the performance prerequisites through structured questioning and active involvement rather than passive observance (Neamah, 2025; Ghanim, 2025).

The enhancement in handstand skill may also be explained by the discovery-learning process and adaptability/flexibility of movement execution. Participants who are introduced to problem-solving situations use their motor coordination and decision-making skills to direct the body and control the actions. Research comparing pedagogical tactics suggest students learning through discovery have greater motor development and retention of handstand than those utilizing traditional methods (El Khouri et al., 2020).

In addition, the instructional program's efficacy is also explained by this combination of factors affecting the individual's motor performance. Performance in the handstand is

reportedly not only determined by muscular strength, but also from environmental conditions, task characteristics and individual differences, which fit with the exploratory nature assigned to guided or divergent discovery styles (Ambrósio et al., 2024).

The divergent discovery form, in particular, promotes the development and exploration of multiple solutions to movement challenges and opportunities for learners to play with alternative performance sequences. This is particularly beneficial for creativity and depth of learning where the child becomes engaged in designing movement responses (a necessary part of both physical education and motor skill learning) (Abdulhussein et al, 2026).

In addition, these data give further credence to research illustrating the role of modern teaching models in gymnastics performance development. In the gymnastics domain, academically rigorous constructivist-based models of teaching proved to have a positive impact on basic learning of early gymnastic skills (e.g., handstand actions) as it generated understanding and involvement in the process of development throughout time (Bayraktar, 2011; Ghanim 2025).

One major unique element of the current study is we integrated guided and divergent discovery within a single instructional context rather than treating them as separate pedagogical approaches. The results suggest young gymnasts did not simply obey the coach's instructions but progressively started to show initiative, exploration, and even creative attempts in executing the handstand swing. This retargeted behavioral output indicates that a combination of structured repetition and unconfined exploration enables both technical precision and independent spontaneous motor behavior.

The data presented here emphasize how guided discovery and traditional teaching can complement each other in promoting the development of appropriate motor responses and behaviors in young gymnasts, in contrast to previous studies that investigated these approaches independently. The study found that the participants gradually gained control of performance variables while also exploring solutions of movements, aligning with modern theories of motor learning, which emphasize versatility and interaction (of learner and task).

Moreover, although they were trained in a controlled environment, clear interindividual differences emerged regarding responsiveness and initiative during skill execution. Few participants trusted in coach guidance at the beginning, while some showed increased independence and exploration with time. The current research presents a distinctive element in this balance between instructor authority and learner-driven learning.

The perceived gain could also be due to the step wise progression of study units, which allowed for feedback and correction after repeated exposure. Studies in gymnastics training shows that practice combined with feedback increases the balance control and motor performance during handstand execution (Kochanowicz et al, 2015).

Additionally, the combination of technology with multiple teaching methods has been demonstrated to aid in learning handstand skills as it promotes participants' motivation and assists learners in understanding movement patterns. In gymnastics, research created digital or interactive learning tools which improved students' handstand performance and engagement (Handayani et al., 2023).

Psychological and moral reasons are also important here. The discovery part of learning will increase self-determination and confidence that carries over to help us keep going, sticking it out, or struggle through until we find mastery. Previous studies demonstrated the significance of motivation and psychological readiness in learning gymnastics, especially for more complex exercises like handstand (Golenkova et al., 2023).

Finally, when juxtaposed with previous research, the distinctive contribution of the present study lies in integrating guided and divergent discovery within a single instructional framework rather than examining each style independently or comparing discovery to traditional command-based approaches. Most earlier studies have either contrasted guided

discovery with direct instruction or investigated discovery methods separately. In contrast, the current study operationalized both approaches sequentially and interactively within the same training sessions, thereby combining structured cognitive guidance with open-ended motor exploration.

The integrated model is especially impressive as it does not rely on high-tech, biomechanical devices or complex reconfigurations of curriculum. Instead, it focuses on structured questioning, graduated task design, and systematic feedback—things that can easily be incorporated into most youth gymnastics training settings. In addition to being theoretically consistent with contemporary motor learning tenets, beyond its relevance in terms of such a context, the study provides a generic, low-cost, and easy-to-implement instructional model coaches and physical education teachers can use to promote acquisition of handstands but also potentially other early gymnastics specialties amongst young constituents.

Limitations

The current study has a number of limitations that need to be taken into account when interpreting the results. The number of participants was not so large and the sample consisted only gymnasts trained in a particular training facility, which may not enable generalization of some findings between other populations or across ages. Further, while DST utilized a one group experimental design without a control condition, which does not allow for conclusions concerning the relative contribution of the instructional intervention per se to learning gains over and beyond natural skill development or ordinary practice. In addition, the time-frame of the training instructional program was limited, and long-term retention of this skill has not been tested. Another limitation was the use of observational evaluation by judges, which despite attempts to be objective, had an element of subjectiveness.

Practical Implications

The results of the current study showed a significant enhancement in performance on the handstand swing task after incorporating guided and divergent discovery instruction styles. Such enhancements in balance control, movement coordination, technical execution, and learner-initiated interaction indicate that a combination of structured guidance to facilitate learning tasks while simultaneously allowing exploratory learning opportunities is an effective approach to assisting young gymnasts with their skill acquisition. For example, coaches and physical education child educators who instruct students within the 10–12-year-old range may develop instructional design units that alternate and provide help with questioning and open-ended movement that encourages exploration. Results show that with the use of this computer-based instruction, young learners were able to not only increase technical accuracy but also build both confidence and autonomy in executing those skills. As a result, adding discovery-based questioning techniques, gradually increasing task complexity, and using structured feedback may improve performance quality but also increase learner engagement.

The study also revealed that even under a controlled training environment, individual differences in responsiveness and creativity emerged. This means that hybrid discovery methods can adapt to differences in learners while still enforcing some degree of structure on the instructional experience. Finally, mixing different discovery models could help curriculum designers and gymnastics coaches include them in training programs for beginner athletes to improve their skills and encourage independent movement development.

Conclusions

The findings of the study show that practice with a guided discovery teaching style and range-focused discovery teaching style has led to pronounced positive learning impact on parallel bars handstand skill among 10 to 12 years old players. These instructional effects were

likely due to student engagement exploration and movement execution understanding of modern learner-centered instruction in motor skill learning and gymnastics training.

Recommendations

From a process-oriented approach, guided discovery and divergent discovery forms of instruction are suggested for gymnastic lesson instructional program in young children because they have been shown to be effective in enhancing motor skill learning. Physical education teachers and coaches should incorporate inquiry-based methods within units of instruction, offer specific feedback during practice. Future studies are recommended to investigate these methods in populations with larger sample sets, different age ranges and the application of more gymnastics skills for additional evidence of effectiveness and practicality.

Conflict of interest

The authors have no conflicts of interest to declare.

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